

CLAIMS

1. A visual display comprising a plurality of pixels each of which comprises:

5 a surface having an area less than 1 square millimeter comprising first and second regions having surface finishes; and

a thin planar panel having first and second sides having surface finishes, wherein said panel is rotatably coupled to said surface so as to rotate between a first and a second position about an axis parallel to said surface, which axis defines a hinge;

10 wherein said panel in said first position is positioned over said first region with its second side facing said first region and wherein in said second position said panel is positioned over said second region with its first side facing said second region.

2. A display according to claim 1, wherein said panel defines an angle between said first position and said second position and where said angle is over 135°.

3. A display according to claim 2, wherein said angle is over 160°.

4. A display according to claim 2, wherein said angle is over 180°.

5. A display according to claim 2, wherein said angle is over 190°.

6. A display according to any of claims 2-5, wherein said angle is under 270°.

7. A display according to claim 1, wherein said panel is in contact with said first region while in said first position.

8. A display according to claim 7, wherein said contact causes stiction between said panel and said region.

9. A display according to claim 7, comprising at least one nub between said panel and said region.

10. A display according to claim 9, wherein said nub is formed on said panel.
11. A display according to claim 9, wherein said nub is formed on said region.
- 5 12. A display according to claim 10, wherein said at least one nub is nearer said hinge than an outer edge of said panel.
13. A display according to any of claims 9-12, wherein said panel contacts both said nub and said region.
- 10 14. A display according to any of claims 9-12, wherein said nub has a tip having a cross-section smaller than another cross-section of said nub.
- 15 15. A display according to any of claims 9-12, wherein said nub has a rounded tip.
16. A display according to any of claims 9-12, wherein said nub has a pitted tip.
17. A display according to any of claims 9-12, wherein said nub has a roughened tip.
- 20 18. A display according to any of claims 9-12, wherein said nub is coated with a stiction reducing coating.
19. A display according to claim 18, wherein said coating comprises an insulator.
- 25 20. A display according to claim 18, wherein said coating comprises Silicon Nitride.
21. A display according to any of claims 9-12, comprising a vibration source underlying said nub.
- 30 22. A display according to claim 21, wherein said vibration source comprises a piezoelectric material.
23. A display according to any of claims 1-21, comprising a vibration source underlying said hinge.

24. A display according to claim 22, wherein said vibration source comprises a piezoelectric material.

5 25. A visual display comprising a plurality of pixels each of which comprises:
a surface comprising first and second regions having surface finishes;
a thin planar panel having first and second sides having surface finishes, wherein said
panel is rotatably coupled to said surface so as to rotate between a first and a second position
about an axis parallel to said surface, which axis defines a hinge; and
10 a layer of insulating material between said plane and said first region,
wherein said panel in said first position is positioned over said first region with its
second side facing said first region and wherein in said second position said panel is positioned
over said second region with its first side facing said second region.

26. A display according to any of claims 1-5, 7-12 or 24, comprising a layer of insulating
material between said plane and said first region.

27. A display according to claim 25, wherein said layer doubles as a colorant.

28. A display according to claim 27, wherein said color properties are determined by a
thickness of said layer.

29. A display according to any of claims 25, 27 or 28, wherein said material comprises
Silicon Nitride.

30. A display according to any of claims 1-5, 7-12, 24, 25, 27, or 28, wherein said pixel is
manufactured using Aluminum on Glass technology.

31. A visual display comprising a plurality of pixels each of which comprises:
a surface comprising first and second regions having surface finishes; and
30 a thin planar panel having first and second sides having surface finishes, wherein said
panel is rotatably coupled to said surface so as to rotate between a first and a second position
about an axis parallel to said surface, which axis defines a hinge;

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wherein said panel in said first position is positioned over said first region with its second side facing said first region and wherein in said second position said panel is positioned over said second region with its first side facing said second region; and

wherein said pixel comprises at least one flipping electrode for flipping said panel
5 between said two positions.

32. A display according to any of claims 1-5, 7-12, 24, 25, 27, or 28, wherein said pixel comprises at least one flipping electrode for flipping said panel between said two positions.

10 33. A display according to claim 31, comprising at least one levitation electrode for moving said panel, thereby aiding said flipping electrode in said flipping out of said first position.

34. A display according to claim 31, comprising at least one levitation electrode for aiding said flipping electrode in said flipping.

15 35. A display according to claim 31 or claim 33, wherein said at least one levitation electrode inhibits said flipping.

20 36. A display according to claim 31 or claim 33, wherein said at least one levitation electrode protrudes above said first region.

37. A display according to claim 31 or claim 33, wherein a same levitation electrode aids flipping both back and forth.

25 38. A display according to claim 31 or claim 33, wherein said at least one levitation electrode is shared between at least two of said pixels.

30 39. A display according to claim 31 or claim 33, wherein said at least one levitation electrode comprises at least two levitation electrodes each one associated with a different pixel and electrified together.

40. A display according to claim 31 or claim 33, comprising circuitry for electrifying said at least one levitation electrode in synchrony with the flipping of a particular pixel.

41. A display according to claim 39, wherein said levitation electrode is electrified prior to electrifying said flipping electrode.

42. A display according to claim 39, wherein said levitation electrode is electrified
5 simultaneously with electrifying said flipping electrode.

43. A visual display comprising a plurality of pixels each of which comprises:
a surface comprising first and second regions having surface finishes; and
a thin planar panel having first and second sides having surface finishes, wherein said
10 panel is rotatably coupled to said surface so as to rotate between a first and a second position
about an axis parallel to said surface, which axis defines a hinge;
wherein said panel in said first position is positioned over said first region with its
second side facing said first region and wherein in said second position said panel is positioned
over said second region with its first side facing said second region; and
15 wherein said panel comprises at least one spring attached thereto, which spring couples
said panel and said first region when said panel is at said first position.

44. A display according to any of claims 1-5, 7-12, 24, 25, 27, 28, 31 or 33, wherein said
panel comprises at least one spring attached thereto, which spring couples said panel and said
20 first region when said panel is at said first position.

45. A display according to claim 43, wherein said at least one spring is an extension of a
sheath portion of said panel, opposite said hinge area.

25 46. A visual display comprising:
at least one vibration source; and
a plurality of pixels each of which comprises:
a surface comprising first and second regions having surface finishes; and
a thin planar panel having first and second sides having surface finishes,
30 wherein said panel is rotatably coupled to said surface so as to rotate between a first and a
second position about an axis parallel to said surface, which axis defines a hinge;
wherein said panel in said first position is positioned over said first region with
its second side facing said first region and wherein in said second position said panel is
positioned over said second region with its first side facing said second region.

47. A display according to any of claims 1-5, 7-12, 24, 25, 27, 28, 31, 33 or 43, comprising at least one vibration source.

5 48. A display according to claim 46, wherein said at least one vibration source comprises a plurality of vibration sources, at least one of them associated with each pixel.

49. A display according to claim 48, wherein said vibration source underlies said hinge.

10 50. A display according to claim 48, wherein said vibration source underlies a contact point between said panel and said first region.

51. A display according to claim 46, wherein said at least one vibration source comprises a vibration source at a periphery of said display.

15 52. A display according to claim 51, wherein said at least one vibration source comprises a piezoelectric vibration source.

20 53. A display according to claim 46, wherein said at least one vibration source comprises circuitry which drives said pixels to vibrate, by varying electric voltages to electrodes in the pixel.

54. A visual display comprising:
a touch-sensitive input; and
25 a plurality of pixels each of which comprises:
a surface comprising first and second regions having surface finishes; and
a thin planar panel having first and second sides having surface finishes,
wherein said panel is rotatably coupled to said surface so as to rotate between a first and a second position about an axis parallel to said surface, which axis defines a hinge;
30 wherein said panel in said first position is positioned over said first region with its second side facing said first region and wherein in said second position said panel is positioned over said second region with its first side facing said second region.

55. A display according to any of claims 1-5, 7-12, 24, 25, 27, 28, 31, 33, 43, 45, 46 or 48-53, comprising a touch-sensitive input.

56. A display according to claim 54, wherein said touch sensitive input comprises a plurality of touch detecting elements replacing a plurality of said pixels in said display and distributed over said display.

57. A display according to claim 56, wherein each of said elements comprises a contact switch and a force transducing element for transferring force from a display to the switch, to close the switch.

58. A display according to claim 56, wherein each of said elements comprises a piezo-resistive element and a force transducing element for transferring force from a display to the piezo-resistive, to modify its resistance.

59. A visual display comprising a plurality of pixels each of which comprises:
a surface comprising first and second regions having surface finishes; and
a thin planar panel having first and second sides having surface finishes, wherein said panel is rotatably coupled to said surface so as to rotate between a first and a second position about an axis parallel to said surface, which axis defines a hinge;

wherein said panel in said first position is positioned over said first region with its second side facing said first region and wherein in said second position said panel is positioned over said second region with its first side facing said second region and

wherein said panel is flipped between said positions by the application of electric voltages to electrodes associated with the pixel and comprising at least one transistor associated with the pixel and formed under said pixel for controlling said application.

60. A display according to any of claims 1-5, 7-12, 24, 25, 27, 28, 31, 33, 43, 45, 46, 48-53 or 56-59, wherein said panel is flipped between said positions by the application of electric voltages to electrodes associated with the pixel and comprising at least one transistor associated with the pixel and deposited under said pixel for controlling said application.

61. A display according to claim 59, wherein said transistor is controlled with a first, low voltage and controls a second, high voltage.

62. A display according to claim 59, wherein said transistor is controlled with a signal of a short duration to allow said application of said voltages for a significantly long duration, at least twice said short duration.
63. A display according to claim 62, wherein said long duration is at least four times said short duration.
64. A display according to claim 62, wherein said long duration is at least eight times said short duration.
65. A display according to any of claims 59 or 61-64, wherein said transistor functions as a switch.
66. A method of flipping a panel in a pixel using electrostatic forces, comprising:
counteracting stiction between said panel and a surface using field generated by applying a voltage to a levitation electrode; and
flipping said panel using a field generated by applying a voltage to a second, flipping, electrode.
67. A method of flipping a panel in a pixel using electrostatic forces, comprising:
counteracting stiction between said panel and a surface by vibrating said panel relative to said surface; and
flipping said panel using a field generated by applying a voltage to a flipping electrode, wherein said vibration is effected by suitable electrifying of a piezoelectric material coupled to said panel.
68. A micro-mechanical device, comprising:
a moving part, having a maximum dimension of less than about 0.01 millimeters;
a stationary part in contact with said moving part;
a force providing element for moving said moving part relative to said stationary part;
and

a separate stiction countering electrode which applies an electrostatic force on said moving part, which force at least assists in breaking stiction at said contact of said stationary part and said moving part.

69. A device according to claim 68, wherein said force providing element comprises an electrode for applying electrostatic forces.

70. A device according to claim 68 or claim 69, wherein said stiction countering electrode interferes with said force providing element.

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